Appendix A

Mobile Source Emissions Modeling for Post-1999 Rate-of-Progress Plan

Mobile Source Emissions Modeling
for Post-1999 Rate-of-Progress Plan

The Georgia Environmental Protection Division (EPD) worked with the Atlanta Regional Commission (ARC) during the summer of 2003 to develop projected mobile source emissions inventories for the Post-1999 Rate of Progress (ROP) state implementation plan (SIP) revision. These inventories reflect the most recent planning assumptions available and the use of updated travel demand, emissions, and emission factor[1] models. The ARC's link-based emissions estimation procedure was employed to estimate mobile emissions. The link-based procedure enables projected mobile source emission inventories for the ROP plan to be calculated in a manner consistent with federal regulations for performing regional emissions analyses used in transportation conformity determinations. This alignment of methodologies for mobile source inventories and transportation conformity emissions analyses prevents spurious differences between motor vehicle emission budgets (i.e., the SIP's estimate of future mobile source emissions) and transportation conformity analyses that must conform to those budgets.

In ozone nonattainment areas with air quality classified as "serious" or worse, the reasonable further progress requirement established in Section 182(c)(2)(B) of the Clean Air Act (CAA) requires emission reductions from the baseline equaling 3% per year, averaged over each consecutive three-year period beginning in 1996 and continuing through the attainment date.[2] In accordance with this requirement, Georgia developed a Post-1996 ROP plan (the 9% Plan). This plan was required to achieve emission reductions of volatile organic compounds (VOCs) and/or nitrogen oxides (NOx) totaling 3% per year from 1996 to 1999, the attainment deadline for serious nonattainment areas. Because photochemical air quality modeling indicates that NOx reductions are more effective than VOC reductions in reducing ozone concentrations in the region, Georgia chose to rely solely on NOx emission reductions in its 9% Plan. The last revision to Georgia's 9% Plan was approved by the U.S. Environmental Protection Agency (EPA) effective[3] April 19, 1999. Because Atlanta failed to attain the ozone standard by November 15, 1999, the area is being reclassified from a serious to a severe ozone nonattainment area and is required to achieve additional reasonable further progress emissions reductions between 1999 and the new attainment date: per the CAA, "as expeditiously as practicable" but no later than November 15, 2005. Consistent with Georgia's modeled demonstration of attainment for the Atlanta area, November 15, 2004, is the attainment date. This yields two additional ROP milestone years after 1999 - 2002 and 2004. Consistent with Georgia's 9% Plan, the Post-1999 ROP plan relies solely on reducing NOx emissions. If the projected NOx emissions for each milestone year are equal to or less than a target level of emissions, developed in accordance with EPA guidance,[4] for that milestone year, the emissions control strategy is sufficient to reduce overall NOx emissions by the required amounts and also to offset all of the growth in NOx emissions projected to occur between 1999 and 2002, and between 2002 and 2004.

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[1] MOBILE6.2 (http://www.epa.gov/otaq/m6.htm#m60)
[2] http://www.epa.gov/air/caa/caa182.txt
[3] Federal Register publication date was March 18, 1999 (64 FR 13348).
[4] http://www.epa.gov/ttn/oarpg/t1/memoranda/post96_2.zip

A revised 1999 NOx target level is needed as a basis for calculating the NOx target level for the first Post-1999 ROP plan milestone year, 2002. Per EPA's "Guidance on the Post-1996 Rate-of-Progress Plan and the Attainment Demonstration[5]," the 1999 target level is established using 1990 activity data with both 1990 and 1999 emission factors. The 1990 emission factors are used to calculate the mobile source portion of the 1990 Base Year inventory, while the 1999 emission factors are used to determine the noncreditable emission reductions that would occur between 1990 and 1999 due to preexisting federal requirements. Subtracting these noncreditable reductions from the Base Year inventory yields an Adjusted Base Year inventory.

According to the EPA's MOBILE6 policy guidance,[6] "If SIPs are revised with MOBILE6, base year...motor vehicle emission inventories will need to be recalculated with the latest available planning assumptions... Base year...inventories should use the best data available for those years." Because no travel demand model network for 1990 was available, it was not possible to use a link-level methodology for the updated 1990 Base Year or for the Adjusted Base Year mobile source inventories. Consistent with Georgia's original 1990 Base Year Ozone Emissons Inventory, 15% Plan, and 9% Plan, mobile source inventories for the 1990 Base Year and the Adjusted Base Years were instead calculated using the inventory methodology[7] described below:

> "[U]se [Federal Highway Administration's (FHWA)] Highway Performance Monitoring System (HPMS) roadway classification scheme to group portions of [vehicle miles traveled (VMT)] by the functional classification of the roadways on which they occur. This results in 12 subsets of VMT. Within each subset, speed is weighted by VMT to calculate an average speed...."

Due to averaging of speeds, emission inventories developed with VMT-weighted average speeds by functional classification have somewhat different emission totals compared with link-level inventories. Inventories developed with averaged speeds generally result in higher VOC and lower NOx emissions, as this comparison of projected 2004 mobile source emissions[8] shows:

Projected 2004 Emissions	**VOC tons/day**	**NOx tons/day**
with link-level speeds	160.56	318.15
with averaged speeds	164.25	303.69

The speed averaging approach is a conservative methodology for developing the Base Year and Adjusted Base Year inventories used in Rate-of-Progress NOx target level

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5 http://www.epa.gov/ttn/oarpg/t1/memoranda/post96_2.zip
6 http://www.epa.gov/otaq/models/mobile6/m6policy.pdf
7 From section 3.3.5.1 of EPA's "Volume IV" guidance, *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*, EPA-420-R-92-009, US EPA, Office of Air and Radiation, Office of Mobile Sources, 1992, http://www.epa.gov/otaq/invntory/r92009.pdf.
8 Note that neither set of inventories reflects the slight emissions increases attributable to the senior exemption from vehicle inspection and maintenence.

calculations because a lower base results in a lower (harder to meet) target level of emissions.

The 1990 speeds used were extrapolated from travel demand model networks (with HPMS codes added) from the ARC. Speeds from each link in networks for 2000, 2002, 2004, and 2005 were processed to develop VMT-weighted average speeds by HPMS functional classification. Speeds for 2001 and 2003 were then interpolated. Finally, Microsoft Excel was used to extrapolate 1990 speeds, using a linear best-fit trend, from the 2000 through 2005 speeds. The travel demand model speeds reflect the results of two speed studies conducted in the Atlanta nonattainment area in 2000 and 2001. A report on the 2000 speed study is here:

http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/Speed_Study.pdf

A technical memorandum on the 2001 speed study is here:

http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/ARC_2001_pbsj_speedstudyTechMemo.pdf

The resulting extrapolated 1990 speeds are shown below, with their respective HPMS functional classification descriptions:

VMT-weighted average speeds for 1990

speed (mph)	functional classification
63.5	Rural Interstate
55.9	Rural Principal Arterial
46.4	Rural Minor Arterial
42.4	Rural Major Collector
43.0	Rural Minor Collector
29.9	Rural Local
52.6	Urbanized Interstate
52.7	Urbanized Other Freeway
41.6	Urbanized Principal Arterial
37.4	Urbanized Minor Arterial
31.2	Urbanized Collector
38.6	Urbanized Local

Note that local speeds are skewed high due to Georgia DOT's practice of assigning "local" HPMS codes (9 and 19) to ramps. However, because MOBILE6 has no input for local street speeds, this has no effect on emission factors.

The ARC produced mobile emissions inventories in support of the ROP plan for milestone years 2002 and 2004. The procedure followed in developing the projected mobile source emissions inventories for the ROP milestone years is detailed below.

Overview – ARC Travel Demand Modeling and Emissions Modeling Methodologies

Two primary variables affecting mobile source emissions estimates are vehicle-miles traveled (VMT) and the speed at which those vehicle-miles are traveled. Within the travel demand model each vehicle trip that occurs during the course of the day is assigned to one of four time-periods, the morning peak period (6:00 a.m. to 10:00 a.m.), the evening peak period (3:00 p.m. to 7:00 p.m.), the mid-day period (10:00 a.m. to 3:00 p.m.) or the nighttime period (7:00 p.m. to 6:00 a.m. the following day). Assigning daily traffic volumes to distinct time periods enables ARC to better account for travel conditions throughout the day. Because travel conditions vary significantly over the course of 24 hours, the time-of-day distinction is critical to delineating accurate speeds and VMT (and, therefore, emissions) within the transportation network. The highway assignment procedure within the travel demand model uses an equilibrium capacity analysis technique to distribute vehicle trips for each time period throughout the roadway network. The equilibration procedure allows up to 30 iterations of assignment, with the iterations stopping after meeting the closure criterion of 0.01 (the ratio of the summation of the loaded network travel times to the projected summation of loaded travel time after capacity-restrained adjustments for the current iteration). Link-based VMT and speeds from each time-of-day assignment are based on final assigned link volumes derived from this equilibration technique. The end product of the equilibrium assignment procedure is four loaded roadway networks-am peak, pm peak, mid-day and nighttime. "Loaded" indicates a network that has been run through a complete travel demand modeling assignment procedure, and therefore has assigned to each link in the network a volume and a congested flow speed.

Link volumes are adjusted based on an HPMS factor. To ensure off-model travel[9] is accounted for within regional emission estimates, EPA requires HPMS-based forecasts of VMT for emissions analyses.[10,11] EPA recommends that HPMS adjustments be made based on comparison of base year VMT from the transportation model to base year HPMS data.[12,13]In Atlanta, for the most recent conformity determination performed for the 2025 Regional Transportation Plan (2002 Update), the VMT from the ARC model runs were summarized by HPMS functional classifications for the base year of model calibration, 2000. Adjustment factors were produced comparing the ARC model results with the HPMS data, which were then applied to the ARC future year VMT estimates by link by functional classification.

Mobile source emissions are calculated by multiplying the HPMS-adjusted VMT for each link in the transportation network by an emission factor that corresponds to the congested

[9] Travel that is accounted for within HPMS data counts, but not accounted for within the coded transportation network.
[10] See transportation conformity rule at 40 CFR Part 93.122(b)(3).
[11] "...EPA and DOT have both endorsed the Highway Performance Monitoring System as the most appropriate means by which to measure VMT...." From Section 3.4.2.1 of EPA's "Volume IV" guidance.
[12] See 40 CFR Part 93.122(b)(3).
[13] See Section 3.4.2.4 of EPA's "Volume IV" guidance.

flow speed of the link. Link level emissions are then summed to the time of day, and daily level, for reporting purposes. The general equation is below:

$$AverageDailyEmissions = \sum (VMTi * EMISSIONFACTORi)$$
where i=each link in the transportation network, for each time-of-day period.

Emission factors were produced for 2.5 mph, then 3 mph to 65 mph, inclusive, in one mile per hour increments for VOC and NOx using the EPA MOBILE6.2 model. The emissions factors are produced based on two types of programs, the federally mandated motor vehicle emission control programs and the locally specific parameters for Atlanta.

Federal Programs	Regional Parameters
National Low Emission Vehicle Standards	Average Fuel Volatility
Heavy-Duty Vehicle Emission Standards	Vehicle Registration Information
Tier 1 Emission Standards	Ambient Temperature
Tier 2 Emission Standards[14]	Inspection & Maintenance Program
	Low-Sulfur Georgia Gasoline

The input files to the MOBILE model are produced by the Georgia EPD and shared with the ARC. This ensures consistency between mobile emission inventories prepared as part of ROP and/or attainment demonstrations and transportation conformity analyses.

Travel Demand Model Enhancements Reflected in Projected Emissions Inventories

As documented by the ARC in Appendix IV of Transportation Solutions for a New Century,[15] the ARC travel demand model is designed to, at minimum, represent the state of the practice in travel demand modeling and to meet all modeling requirements specified in the federal Transportation Conformity Rule (40 CFR Parts 51 and 93)[16]. Since 1990, a full consultation process including a national peer review, and the ARC strategic travel demand model enhancement program have guided all modifications to the travel demand model. As a result, all elements of the travel demand model are designed to support all technical and policy decisions that are required in developing a comprehensive, multimodal transportation plan and program in accordance with the Transportation Equity Act for the 21st Century (TEA-21), the 1990 Clean Air Act Amendments and the Transportation Conformity Rule.

A number of enhancements have been applied to the travel demand model since January 7, 2003, when the latest conforming transportation plan and program were approved by the U.S. Department of Transportation (USDOT), in consultation with the EPA. Changes

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[14] (beginning with 2004 models)

[15] Detailed documentation of the travel demand modeling system can be found in Appendix IV of Transportation Solutions for a New Century, http://www.atlantaregional.com/transportationair/rtptipdownload.html

[16] 40 CFR Parts 51 and 93, Transportation Conformity Rule Amendments: Flexibility and Streamlining: Final Rule, August 15, 1997, http://www.epa.gov/fedrgstr/EPA-AIR/1997/August/Day-15/a20968.htm

are a result of a significant model recalibration initiated after the release of the decennial 2000 Census data. Enhancements include updated population and employment estimates that reflect Census results as well as structural changes within the model needed to recalibrate to the updated data in the base year, 2000.

2000 Census data was used in the development of the socioeconomic forecasts for the ROP milestone years of 2002 and 2004. The first step in producing socioeconomic forecasts for these years was development of revised regional control totals. The 2000 Census showed the population of the 10 county Atlanta region to be 3,429,379 persons. ARC's 2003 estimate shows the region's average annual population increase, 2000-2003, to be 79,974. Applying the average annual increase to the two-year period, April 1, 2000, to April 1, 2002, produces an estimate of 3,589,327.

The table below shows 2000 Census results for the three additional counties in the one-hour ozone nonattainment area and the Census Bureau's estimate of July 1 population for these counties in 2002, along with ARC's adjustment of the 2002 estimate to an April 1 date to make them comparable to ARC's estimates. The result is an April 1, 2002, estimate of 3,895,161 for the population of the 13-county air-quality nonattainment area.

Table A-1
Population Data for the 13-County Nonattainment Area

2000 Census Data	**Population April 1, 2000**	**Population July 1, 2002**	**Population April 1, 2002**
Coweta	89,215	97,771	97,113
Forsyth	98,407	116,924	115,500
Paulding	81,678	94,184	93,222
Total	269,300	308,879	305,834
10-County ARC Region	3,429,379	N/A	3,589,327
13-County area	3,698,679		3,895,161

Interpolation using ARC's latest regional control forecasts shows this figure of 3,895,161 being reached in 2004.41. This may be restated as saying that reality is running 2.41 years ahead of the trend line. On this basis, revised regional control totals for 2004 and 2005 were interpolated as the previous regional control forecast for 2006.41 and 2007.41. The table below summarizes the revised control totals.

Table A-2
Revised Regional Controls Reflecting 2000 Census

Demographic Variables	**2002**	**2004**	**2005**
Population	3,895,031	4,006,464	4,066,864
Households	1,432,556	1,482,280	1,510,280
Population in Households	3,821,881	3,930,070	3,988,630
Average Household Size	2.67	2.65	2.64
Group Quarters	73,150	76,394	78,234
Employment	**2002**	**2004**	**2005**
Total	2,182,085	2,250,634	2,288,367
Construction	102,338	103,346	105,025
Manufacturing	190,056	193,386	195,225
TCU	192,584	196,779	199,741
Wholesale	188,150	193,178	195,980
Retail	397,519	413,419	422,407
Fire	145,791	149,136	150,826
Service/Miscellaneous	703,992	733,480	747,638
Government	261,655	267,910	271,525

Small area (Traffic Analysis Zone (TAZ)) information for 2002 was obtained via the following methodology:

- Calculated regional capture rates, by TAZ, of households and employment 1990-2000.
- Applied regional capture rates, by TAZ, to the difference between the 2000 base and the revised 2002 control, to obtain initial values by TAZ for total households and total employment.
- Adjusted regional capture rates as needed to reflect recent 2000-2002 conditions, to obtain final total employment and total household "goals" by TAZ.
- For employment, matrix factored total employment goals, by TAZ, into employment category totals by TAZ, using 2000 category distribution by TAZ as a base.
- For households, 2002 marginals for total households by income by size were constructed, using 2000 as a base. Then, the total household goals (derived above), by TAZ, were matrix factored to equalize to, at the regional level, the derived 2002 marginals. 2000 base data (for the households by income by size categories) was used to “seed” this matrix factor process.

Small area (TAZ) information for 2005 was obtained using similar methodology. Initial 2005 population and employment marginals were derived using the 2002 forecast as a base, the 1990-2000 capture rates, and the new 2005 regional controls. Final goals, by TAZ, for 2005 were developed with extensive input from ARC's Land Use division. Households by income by size and employment by industry were derived using matrix factoring using the 2002 results as the initial values.

Initial 2004 population and employment marginals were derived from the final 2002 and 2005 marginals by interpolation and then proportionately adjusted to sum to the 2004 regional controls. Again, matrix factoring was used to derive households by income by size and employment by industry detail.

Emissions Modeling Enhancements Reflected in Projected Emissions Inventories

As documented in Volume III of Transportation Solutions for a New Century, the ARC uses a traditional link-based procedure as an element of the travel demand model chain to develop mobile source emission estimates for conformity analyses. The link-based procedure enables emissions to be calculated in a manner consistent both with federal transportation conformity regulations that direct regional emissions analyses, as well as with EPD methodology used to prepare the mobile source emission inventories for the Attainment SIP (and associated reasonable further progress modeling).[17]

Since December of 2002, the emissions modeling methodology has not changed, but has been updated to reflect changes within the travel demand model resulting from the recalibration to 2000 Census data, as well as the release of the new MOBILE6 emission factor model. The emissions model was also converted to an automated TP+ platform.[18]

The TP+ procedure requires input of loaded travel model networks for the a.m., p.m., mid-day, and nighttime travel periods for a specific scenario year, in this case 2002 and 2004. External files that define HPMS adjustment factors and MOBILE6 emission factors are also required. Development of each of these external files for use in the projected emissions inventories is described below. Loaded network files that list VMT, speeds, FIPS[19] code, facility type code, HPMS functional class code, VOC and NOx, etc., by time of day for each network link are produced by the emissions model. These files were imported into database tables and daily emissions were then summarized by county. The loaded network files (ASCII format) are contained in a compressed file available here:
http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/02_and_04_loaded_networks.zip

Note that the compressed file is large -- 7.5 megabytes -- and that when expanded the two loaded network files together total 28 megabytes. The data tables and the SQL queries used to summarize 2002 and 2004 link-level emissions are contained in a compressed Microsoft Access 97 file available here:
http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/02_and_04_network_database.zip

This file is quite large: 33 megabytes compressed, 93 megabytes expanded.

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[17] Detailed documentation of the mobile source emissions modeling process can be found in Volume III of Transportation Solutions for a New Century,
http://www.atlantaregional.com/transportationair/rtptipdownload.html, and in *Emissions Post_Processor Documentation*, http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/Emissions_Post-Processor.pdf

[18] TP+ (Transportation Planning +) is the software employed by ARC for travel demand modeling.

[19] Federal Information Processing Standard, a numerical code indicating state and county.

Travel Model Networks

To prepare the projected mobile source emissions inventories for the ROP plan, it was necessary to create a 2002 transportation network that accurately reflected the transportation system in place during that year, as well as a transportation network for 2004 that reflected the current conforming transportation plan and program. A 2000 transportation network was created as part of the full travel demand model recalibration effort discussed above. The 2002 and 2004 transportation networks were constructed by adding only those transportation projects open-to-traffic by 2002 and 2004, respectively, to the 2000 network. Year 2002 and 2004 networks were run through a full assignment procedure, based on the recalibrated model stream, to produce the respective mobile source emission inventories.

Table A-3 delineates each column and corresponding field description within a loaded network that is produced in the emissions modeling process.

Table A-3
Loaded Network Produced by MOBILE6 Script

Column	Field Description
A	Anode
B	Bnode
C	Area Type
D	Original Facility Type
E	Distance (Hundredths of Mile)
F	Number of Lanes
G	Capacity (Hourly)
H	Split Link Flag (Rural Other Principal Arterial)
I	Revised Facility Type
J	HPMS Code
K	Morning Free Flow Speed
L	Morning Congested Flow Speed
M	Morning Total Volume
N	Morning Total Volume - SOV
O	Morning Total Volume - Truck
P	Morning Post Processed Congested Flow Speed (Rounded)
Q	Morning Total VMT
R	Morning Total VOC
S	Morning Total NOx
T	Mid-Day Free Flow Speed
U	Mid-Day Congested Flow Speed
V	Mid-Day Total Volume
W	Mid-Day Total Volume - SOV
X	Mid-Day Total Volume - Truck
Y	Mid-Day Post Processed Congested Flow Speed (Rounded)
Z	Mid-Day Total VMT
AA	Mid-Day Total VOC
AB	Mid-Day Total NOx
AC	Evening Free Flow Speed
AD	Evening Congested Flow Speed

AE	Evening Total Volume
AF	Evening Total Volume - SOV
AG	Evening Total Volume - Truck
AH	Evening Post Processed Congested Flow Speed (Rounded)
AI	Evening Total VMT
AJ	Evening Total VOC
AK	Evening Total NOx
AL	Night-Time Free Flow Speed
AM	Night-Time Congested Flow Speed
AN	Night-Time Total Volume
AO	Night-Time Total Volume - SOV
AP	Night-Time Total Volume - Truck
AQ	Night-Time Post Processed Congested Flow Speed (Rounded)
AR	Night-Time Total VMT
AS	Night-Time Total VOC
AT	Night-Time Total NOx
AU	FIPS Code
AV	Driving Cycle
AW	Anode X-Coordinate
AX	Anode Y-Coordinate
AY	Bnode X-Coordinate
AZ	Bnode Y-Coordinate

HPMS Adjustment Factors
Section 93.122, Procedures for Determining Regional Transportation Related Emissions, of the Transportation Conformity Rule states the following:

> *"Highway Performance Monitoring System (HPMS) estimates of vehicle miles traveled (VMT) shall be considered the primary measure of VMT within the portion of the nonattainment or maintenance area and for the functional classes of roadways included in HPMS…For areas with network-based travel models, a factor (or factors) may be developed to reconcile and calibrate the network-based travel model estimates of VMT in the base year of its validation to the HPMS estimates for the same period. These factors may then be applied to model estimates of future VMT."*

Section 3.4.2.4 of EPA's "Volume IV" guidance, states that "...[T]he detailed VMT estimates produced by the transportation planning process should be made consistent...with HPMS." Section 3.4.1.3.3 of the Volume IV guidance additionally states that the "HPMS-based annual average daily VMT should also be adjusted for seasonal effects…VMT for ozone non-attainment areas should be adjusted to the summer season…"

HPMS adjustment factors were developed based on average daily, summer-adjusted HPMS VMT estimates for the year 2000, the base year of travel model calibration. The HPMS adjustment enables link-based VMT to be reconciled to observed summertime travel conditions at the functional class level.

The following equation was used to calculate the HPMS adjustment factors:

HPMS Adjustment $Factor_i$ = 2000 HPMS VMT_i / 2000 MODEL VMT_i
(where i=HPMS functional class)

To determine the "2000 HPMS VMT," average daily VMT for the year 2000 was grouped by the 12 HPMS functional classes for each of the 13 nonattainment counties using the Georgia Department of Transportation's (GDOT) Office of Transportation Data 445 report. The 445 report provides information on mileage and VMT by route type and road system and contains county specific State Route, County Road and City Street mileage and VMT broken down by functional classification. Average daily VMT was then summer-adjusted using latest available summer adjustment factors provided by GDOT. Summer-adjusted VMT by county and functional class were aggregated to total VMT by HPMS functional class. "2000 Travel Demand Model VMT" at the HPMS functional class level was derived from the recalibrated 2000 travel model network. Table A-4 below reflects 2000 HPMS and model VMT by functional class, along with the HPMS adjustment factors.

Table A-4

HPMS Functional Class (Code)	**2000 HPMS VMT** Summer-Adjusted Average Daily VMT	**2000 Travel Demand Model VMT** Average Daily VMT	**HPMS Adjustment Factors**
Rural Interstate (1)	5,840,728	8,488,287	0.69
Rural Principal Arterial (2)	3,569,720	3,145,462	1.13
Rural Minor Arterial (6)	3,811,482	3,168,965	1.20
Rural Major Collector (7)	3,708,389	3,452,056	1.07
Rural Minor Collector (8)	1,249,317	1,091,894	1.14
Rural Local (9)	3,490,796	12,864,647	0.27
Urban Interstate (11)	37,694,171	34,376,364	1.10
Urban Other Freeway (12)	6,478,628	2,348,406	2.76
Urban Principal Arterial (14)	10,350,324	15,653,577	0.66
Urban Minor Arterial (16)	21,924,642	18,473,757	1.19
Urbanized Collector (17)	7,617,087	6,174,256	1.23
Urbanized Local (19)	15,412,042	7,999,419	1.93
Total VMT	121,147,325	117,237,090	

Emission Factors

In January 2002, EPA released the MOBILE6 emission factor model for distribution. There are significant changes between MOBILE5b and MOBILE6. This is the first major change to EPA's MOBILE program in many years. The changes in MOBILE6 range from changes in the emission standards, fleet and activity data to structural formats and input/output formats. The basic exhaust emissions rates have been updated based on current in-use deterioration estimates and on new federal emission standards. The emissions have been revised based on a variety of improvements and enhancements to the data assumptions. Some of the revised input data assumptions are listed below.

- Off-Cycle Effects
    - Include air conditioning effects

- Fuel Composition
    - Updated effects of oxygenated fuel on CO emissions
    - Explicit effects of sulfur on exhaust emissions

- Fleet Characterization
    - New national average mileage accumulation estimates
    - New national average registration (age) distribution
    - New national vehicle class counts

- Driving Behavior
    - New in-use driving cycles
    - Facility-based speed corrections
    - Separate estimates for freeway ramps

- Evaporative Emissions
    - New data collected in real-time replaces old one-hour diurnal data
    - New data supplements

- Vehicle Activity
    - New trip length estimates
    - Engine start soak time distributions
    - Diurnal soak time distributions
    - Trip start and trip ends

- Heavy Duty Emissions
    - New emissions standards
    - New conversion factors
    - New fleet estimates

- Expanded Vehicle Classes
    - Four light-duty truck subcategories
    - Nineteen heavy-duty truck and bus subcategories
    - Also includes same eight aggregated MOBILE5 vehicle categories

- Emissions by roadway type
    - Emissions facility specific

- Driving Cycle Correction Factors
    - Adjusted for different average speeds
    - Adjusted for different roadway type

- o Adjusted for non-standard driving behavior

All of the data assumptions above have been based on new and more current data. The Federal Test Procedure (FTP) has been expanded to include a large sample of emission factor tests and to include a variety of vehicle types and technologies. The basic emission rates were derived from emissions tests conducted under standard conditions such as temperature, fuel and driving cycle. Emission rates further assume a pattern of deterioration in emissions control device performance over time, again based on results of standardized emission tests. The results from other studies have been incorporated into the changes, such as the California study on the effects of soak time on emission. In addition, other studies were conducted with instrumented vehicles to examine the number of vehicle starts per mile and the average soak time distribution. These changes, most of which are transparent to the MOBILE6 user, and are incorporated in the actual emissions produced. These changes will also be determined by the input specifications provided by the user. As stated above, the Georgia EPD is responsible for developing the input specifications to the MOBILE model. ARC works closely with Georgia EPD on this effort to ensure consistency between the development of the SIP and the conformity process.

The most important change in the MOBILE model affecting the emissions modeling procedure is the implementation of emissions by roadway type. MOBILE6 estimates emissions for four types of roadways - arterials/collectors, freeways/interstates, ramps, and local roads. It is assumed that all VMT by highway motor vehicles will occur on one of these four roadway types. Each roadway type implies different assumptions about vehicle activity and different emission estimates in MOBILE6. EPA separates facilities by driving cycle operations. The definitions of the different facility types from EPA's *Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation* are listed below.[20]

- Freeway Driving Cycle

In MOBILE6, "freeway" VMT refers to driving that occurs on roadways that do not have traffic signals, that usually have limited access (via converging ramps) and have free flow speeds greater than 50 miles per hour. These roadways are usually divided and have more than one lane in each direction. This definition does not include short sections (less than two miles) of a roadway between signals, but could include longer roadway segments that effectively act as freeways.

- Arterials/Collector Driving Cycle

In MOBILE6, "arterial/collector" VMT refers to driving that occurs on roadways that have signalized traffic control. These roadways are not freeways, because they have traffic signals, but they may be divided, multiple lanes, one-way and have high free-flow speeds. However, traffic will be stopped periodically by traffic signals and will be further affected by access to the roadway by driveways and un-signalized intersections.

[20] http://www.epa.gov/otaq/models/mobile6/m6techgd.pdf

Even in free flow, the driving on arterial/collector roadways will be characterized by cruising periods interrupted by traffic signals.

- Local Roadway Driving Cycle

In MOBILE6, "local roadway" VMT refers to driving on roadways which are not normally considered as part of the traffic network. These roadways do not have traffic lights and rarely have more than one lane in each direction. They usually allow vehicle parking on the roadway surface and traffic control is handled via stop/yield signs. Speed limits are normally 30 miles per hour or less. The driving cycle used in MOBILE6 to model local roadways is fixed at an average speed of 12.9 miles per hour. Driving on local roadways is characterized by extremely low speeds and frequent stops at intersections.

- Freeway Ramp

In MOBILE6, "freeway ramp" VMT refers to the access roadways for freeways. It includes both traffic entering the freeway and exiting. Driving on freeway ramps is characterized by rapid acceleration from stop or low speeds to freeway speeds and decelerations from freeway speeds to low speeds or stop. Freeway ramp activity is not included in the MOBILE6 freeway roadway definition. Therefore, all freeway activity must include a corresponding freeway ramp activity to account for acceleration and deceleration to and from freeway speeds.

Many areas do not explicitly account for freeway ramps as a separate roadway type so EPA developed a default ramp fraction (8% of freeway travel) for MOBILE6 users to account for this. This procedure does not need to be utilized for Atlanta's emission estimates because freeway ramps have been explicitly defined in the ARC highway network. Freeway ramps have been defined as separate facilities stratified by the type of design and speed, high, medium and low. High-speed ramps represent ramps that connect freeway-to-freeway travel, such as I-285 to I-85N, while the lower speed ramps are for access to a freeway from an arterial or egress from a freeway to an arterial. The high-speed ramps in the ARC model have significantly higher free-flow speeds than the lower speed ramps and are not characterized by rapid acceleration or by deceleration from freeway speeds to low speeds or stops. Based on guidance from EPA, emissions for high-speed freeway ramps should be estimated using the freeway emissions while emissions for lower speed freeway ramps should be estimated using the freeway ramp emissions.

Only emissions for arterials/collectors and freeways/interstates are speed sensitive. Emission factors were produced for 2.5 miles per hour and, in one mile per hour increments, between 3 mph and 65 mph, inclusive, for these two roadway types.

The all-vehicles emission factors were used to perform the projected mobile source emissions inventories. MOBILE6 emissions now account for the federal controls being implemented on heavy-duty vehicles. MOBILE6 also allows the emissions reductions associated with Georgia's low sulfur fuel to be directly modeled with MOBILE6.

EPA has included in the documentation of MOBILE6 the mapping of FHWA highway functional system classifications to the appropriate MOBILE6 roadway type.

Table A-5
Listing of FHWA Highway Functional Classifications
Mapped to MOBILE6 Roadway Types

FHWA Highway Functional System	MOBILE6 Roadway Type
Rural interstate	Freeway and freeway ramp
Rural other principal arterial	Freeway and freeway ramp
Rural minor arterial	Arterial/collector
Rural major collector	Arterial/collector
Rural minor collector	Arterial/collector
Rural local	Local
Urban interstate	Freeway and freeway ramp
Urban other freeways	Freeway and freeway ramp
Urban other principal arterial	Arterial/collector
Urban minor arterial	Arterial/collector
Urban collector	Arterial/collector
Urban local	Local

The appropriate MOBILE6 roadway type can be determined by using the facility type definitions in the highway network except for the rural other principal arterial. EPA believes that facilities with the HPMS classification of rural other principal arterial should be modeled using a combination of the freeway and ramp emission factors. EPA has recommended that the freeway emission factors be applied to 92% of the VMT while the ramp emission factors be applied for the remaining 8% of the VMT for these facilities. This is the only case where a combination of emission factors by type is used for the same facility classification. In the ARC highway networks, facilities with rural other principal arterial HPMS classifications have different facility types, ranging from expressway to different types of arterials. Within the TP+ emissions modeling procedure the HPMS functional classification and facility type for each link are checked to determine the appropriate MOBILE6 roadway type for this category. Only facilities with a facility type of arterial or collector and an HPMS classification of rural other principal arterial will have the VMT adjusted based on the above criteria. Facilities with a freeway facility type and an HPMS classification of rural other principal arterial will not be adjusted. Table A-6 lists the mapping of the ARC facility type definitions to the MOBILE6 roadway types.

Table A-6
Listing of ARC Facility Type Classifications
by MOBILE 6 Roadway Type

Facility Type Classification	Code	Area Type	MOBILE6 Roadway Type
Interstate/Freeways	1	Urban/Rural	Freeway
Parkway	2	Urban/Rural	Freeway
HOV Buffer Separated	3	Urban/Rural	Freeway
HOV Barrier Separated	4	Urban/Rural	Freeway
High Speed Ramps/CD Roads	5	Urban/Rural	Freeway
Principal Arterial – Class I*	12	Rural	Arterial/collector or Freeway and Ramp
Principal Arterial – Class I	12	Urban	Arterial/collector
Principal Arterial – Class II*	13	Rural	Arterial/collector or Freeway and Ramp
Principal Arterial – Class II	13	Urban	Arterial/collector
Minor Arterials – Class I*	14	Rural	Arterial/collector or Freeway and Ramp
Minor Arterials – Class I	14	Urban	Arterial/collector
Minor Arterials – Class II*	15	Rural	Arterial/collector or Freeway and Ramp
HOV Arterials	16	Urban/Rural	Arterial/collector
Major Collector	17	Urban/Rural	Arterial/collector
Minor Collector	18	Urban/Rural	Arterial/collector
Medium Speed Ramp	6	Urban/Rural	Ramp
Low Speed Ramp	7	Urban/Rural	Ramp
Loop Ramp	8	Urban/Rural	Ramp
Off Ramp w/Intersection	9	Urban/Rural	Ramp
On Ramp w/Intersection	10	Urban/Rural	Ramp
Planned Ramps w/Intersections	19	Urban/Rural	Ramp
Planned Directional Ramps	20	Urban/Rural	Ramp
Centroid Connectors	0	Urban/Rural	Local

**If HPMS classification is Rural Other Principal Arterial- 92% of VMT allocated to freeway while 8% allocated to ramp*

Specific input variables updated within MOBILE6 for the mobile source emissions inventories are documented below.

- Ambient Weather Conditions

MOBILE6 allows relative humidity and temperature to be input for each hour of the day, with a single entry for barometric pressure. Hourly humidity and temperature inputs were derived from National Weather Service Local Climatological Data from the same days used to develop the minimum and maximum temperature inputs for the mobile source modeling in the original 1990 Base Year Inventory and in all subsequent control strategy SIP revisions. Per EPA guidance, these are the 10 days with the highest ozone concentrations for the three-year period 1988-1990. Consistent with the previous inventory and SIP modeling, the 11 days with the highest ozone were used; note that the same average minimum and maximum temperatures result whether using data from the 10 highest or the 11 highest ozone days. The hourly humidities and temperatures were averaged across the 11 days. The daily average barometric pressures for the 11 days were also averaged. See Exhibit 1 for details.[21]

- Fleet Age

For the updated 1990 Base Year mobile source inventory, the local vehicle registration distribution by age data used for modeling the mobile source emission factors for the original 1990 Base Year Emissions Inventory was used.[22] The 1990 age distribution was derived from registration data obtained from the Motor Vehicle Division of the Georgia Department of Revenue. For the Adjusted Base Year inventories and for the Projected Inventories, an updated registration distribution by age,[23] developed using registration data obtained from R.L. Polk & Company, was modeled. In keeping with EPA guidance,[24] the MOBILE6 default distribution was used for the heaviest (Class 8B) heavy-duty vehicles.

- Gasoline

The 2002 and 2004 Projected mobile source emissions inventories reflect the effects of the low-sulfur (150 parts per million average in 2002, 30 parts per million average in 2004) and low Reid Vapor Pressure (7.0 pounds per square inch) gasoline required by state rule in the nonattainment area.

- Vehicle Inspection and Maintenenace Program

The vehicle inspection and maintenance (I/M) program in place in 1990 was modeled for the 1990 Base and Adjusted Base Year mobile source inventories. This was a decentralized program for 12-years-old-and-newer cars and light trucks in Cobb, DeKalb, Fulton, and Gwinnett counties. The annual program consisted of an idle test and a check for tampering of three items: air pump system, catalytic converter, and fuel inlet restrictor. For 2002 and 2004 mobile source emissions modeling, the enhanced I/M program[25] in place in the entire 13-county nonattainment area was modeled. This annual program requires onboard diagnostics system checks on 1996 and newer model year cars

[21] http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_1_hourly_temp_and_humidity.xls
[22] See Exhibit 2, http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_2_90regdis.pdf
[23] Registration data was from R. L. Polk & Co.'s National Vehicle Population Profile ® current as of October 2002 and from R. L. Polk & Co.'s TIPNet ® current as of March 2003. See Exhibit 3, http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_3_02regis2.pdf, for more details on the new registration distribution by age.
[24] "EPA encourages and recommends the use of actual locality-specific...registration distributions by age in the development of SIP emission inventories. One exception to this would be areas having relatively few local HDDV registrations, but significant interstate trucking activity within the local area. Such areas may want to retain and use the [MOBILE] national registration distributions." Section 2.2.3.6, "User's Guide to Mobile5."
[25] See Rules for Enhanced Inspection and Maintenance, Chapter 391-3-20, http://www.dnr.state.ga.us/dnr/environ/rules_files/exist_files/391-3-20.pdf

and light trucks, 2-mode ASM tests on 25-year-old through 1995 model year vehicles; and a check for catalytic converter tampering and a gas cap pressure test on all subject vehicles.

- VMT Fractions

Consistent with mobile source modeling for the original 1990 Base Year Inventory, MOBILE default VMT (vehicle miles traveled) fractions[26] were used to model the updated 1990 Base Year inventory. In the past, VMT fractions for projected inventories have been derived from data submitted each year by GDOT to FHWA. These data were published for the years 1993 through 1999[27] in Table VM-4, part of FHWA's Highway Statistics[28] series. But because these data are not reflecting the trend towards increasing travel by light trucks,[29] it was more conservative to assume MOBILE6 default VMT fractions for the Adjusted Base Year and the 2002 and 2004 Projected inventories.

All of the MOBILE6 input variables are specified in the input files. Exhibit 5 contains Adobe Acrobat versions of the MOBILE6.2 input files used to model emission factors for the 1990 Base and Adjusted Base Years:
http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_5_base_and_adj_base_inputs.pdf

Exhibit 6 contains abbreviated versions of the input files used to calculate emission factors for the link-level 2002 Projected mobile source inventories. There is a separate scenario in each input for each of 64 speeds, with only the speed varying. To conserve space, most of the speed scenarios are omitted from these inputs:
http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_6_02_inputs.pdf

Exhibit 7 contains similarly abbreviated versions of the input files used to calculate emission factors for the link-level 2004 Projected mobile source inventories:
http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_7_04_inputs.pdf

Exhibit 8 is a compressed file containing the complete MOBILE6.2 input files (filename.IN), plus the output (filename.TXT), post-processed output (filename.CSV) and supporting files (filename.D) used in modeling the mobile source emission inventories for the Post-1999 ROP plan (all these files are in ASCII text format). The archive also contains the Excel 97 workbooks used to calculate the Base and Adjusted Base Year mobile source inventories:
http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_8_mobile_files.zip

[26] (the fraction of total vehicle miles traveled by each vehicle type)
[27] Data for 2000, 2001, and 2002 have since been obtained from GDOT.
[28] http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm
[29] See Exhibit 4, http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_4_vmt_fractions.pdf. Supporting files for Exhibit 4 are available here:
http://www.dnr.state.ga.us/dnr/environ/plans_files/plans/exhibit_4_supporting_files.zip